EMI8131, EMI8132, EMI8133

Common Mode Filter with ESD Protection

Functional Description
The EMI813x is a family of Common Mode Filters (CMF) with integrated ESD protection, a first in the industry. Differential signaling I/Os can now have both common mode filtering and ESD protection in one package. The EMI813x protects against ESD pulses up to ±15 kV contact per the IEC61000−4−2 standard.
The EMI813x is well−suited for protecting systems using high−speed differential ports such as MIPI D−PHY; corresponding ports in removable storage, and other applications where ESD protection are required in a small footprint package.
The EMI813x is available in a RoHS−compliant, XDFN−10 for 2 Differential Pair and XDFN−16 package for 3 Differential Pair.

Features
• Total Insertion Loss DMLOSS < 3.7 dB at 2.5 GHz
• Large Differential Mode Cutoff Frequency f3dB > 2.5 GHz
• High Common Mode Stop Band Attenuation
• Low Channel Resistance 6.0 Ω
• Provides ESD Protection to IEC61000−4−2 Level 4, ±15 kV Contact
• SZ Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC−Q101 Qualified and PPAP Capable
• These Devices are Pb−Free, Halogen Free/BFR Free and are RoHS Compliant

Applications
• USB 3.0
• MHL 2.0
• μSD Card
• eSATA
• HDMI/DVI Display in Mobile Phones
• MIPI D−PHY (CSI−2, DSI, etc) in Mobile Phones and Digital Still Cameras

Figure 1. EMI8131 Electrical Schematic

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Figure 1. EMI8131 Electrical Schematic

### PIN FUNCTION DESCRIPTION

<table>
<thead>
<tr>
<th>Pin Name</th>
<th>Device Pin</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>In_1+</td>
<td>1</td>
<td>I/O</td>
<td>CMF Channel 1+ to Connector (External)</td>
</tr>
<tr>
<td>In_1−</td>
<td>2</td>
<td>I/O</td>
<td>CMF Channel 1− to Connector (External)</td>
</tr>
<tr>
<td>Out_1+</td>
<td>6</td>
<td>I/O</td>
<td>CMF Channel 1+ to ASIC (Internal)</td>
</tr>
<tr>
<td>Out_1−</td>
<td>5</td>
<td>I/O</td>
<td>CMF Channel 1− to ASIC (Internal)</td>
</tr>
<tr>
<td>In_2+</td>
<td>NA</td>
<td>I/O</td>
<td>CMF Channel 2+ to Connector (External)</td>
</tr>
<tr>
<td>In_2−</td>
<td>NA</td>
<td>I/O</td>
<td>CMF Channel 2− to Connector (External)</td>
</tr>
<tr>
<td>Out_2+</td>
<td>NA</td>
<td>I/O</td>
<td>CMF Channel 2+ to ASIC (Internal)</td>
</tr>
<tr>
<td>Out_2−</td>
<td>NA</td>
<td>I/O</td>
<td>CMF Channel 2− to ASIC (Internal)</td>
</tr>
<tr>
<td>In_3+</td>
<td>NA</td>
<td>I/O</td>
<td>CMF Channel 3+ to Connector (External)</td>
</tr>
<tr>
<td>In_3−</td>
<td>NA</td>
<td>I/O</td>
<td>CMF Channel 3− to Connector (External)</td>
</tr>
<tr>
<td>Out_3+</td>
<td>NA</td>
<td>I/O</td>
<td>CMF Channel 3+ to ASIC (Internal)</td>
</tr>
<tr>
<td>Out_3−</td>
<td>NA</td>
<td>I/O</td>
<td>CMF Channel 3− to ASIC (Internal)</td>
</tr>
<tr>
<td>VN</td>
<td>3, 4, 3, 8</td>
<td></td>
<td>Ground</td>
</tr>
</tbody>
</table>

### ABSOLUTE MAXIMUM RATINGS (T_A = 25°C unless otherwise noted)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating Temperature Range</td>
<td>T_OP</td>
<td>−40 to +85</td>
<td>°C</td>
</tr>
<tr>
<td>Storage Temperature Range</td>
<td>T_STG</td>
<td>−65 to +150</td>
<td>°C</td>
</tr>
<tr>
<td>Maximum Lead Temperature for Soldering Purposes (1/8&quot; from Case for 10 seconds)</td>
<td>T_L</td>
<td>260</td>
<td>°C</td>
</tr>
<tr>
<td>DC Current per Line</td>
<td>I_LINE</td>
<td>100</td>
<td>mA</td>
</tr>
</tbody>
</table>

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.
### ELECTRICAL CHARACTERISTICS \((T_A = 25{\degree}C\) unless otherwise noted\)

<table>
<thead>
<tr>
<th>Symbol (\text{Parameter})</th>
<th>Test Conditions</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>(V_{\text{RWM}}) (\text{Reverse Working Voltage})</td>
<td>(Note 3)</td>
<td>3.3</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>(V_{\text{BR}}) (\text{Breakdown Voltage})</td>
<td>(I_T = 1\ \text{mA};) (Note 4)</td>
<td>4.0</td>
<td></td>
<td>9.0</td>
<td>V</td>
</tr>
<tr>
<td>(I_{\text{LEAK}}) (\text{Channel Leakage Current})</td>
<td>(T_A = 25{\degree}C,\ \text{VIN} = 3.3\ \text{V, GND} = 0\ \text{V})</td>
<td></td>
<td>1.0</td>
<td></td>
<td>(\mu\text{A})</td>
</tr>
<tr>
<td>(R_{\text{CH}}) (\text{Channel Resistance})</td>
<td>(\text{Pins 1–6, 2–5) – EMI8131}) (</td>
<td>\text{Pins 1–10, 2–9, 4–7 and 5–6) – EMI8132}) (</td>
<td>\text{Pins 1–16, 2–15, 4–13, 5–12, 7–10 and 8–9) – EMI8133})</td>
<td>6.0</td>
<td></td>
</tr>
<tr>
<td>(\text{DMLOSS}) (\text{Differential Mode Insertion Loss})</td>
<td>@ 2.5 GHz</td>
<td>3.7</td>
<td></td>
<td></td>
<td>dB</td>
</tr>
<tr>
<td>(f_{\text{3dB}}) (\text{Differential Mode Cut-off Frequency})</td>
<td>50 (\Omega) Source and Load Termination</td>
<td>2.5</td>
<td></td>
<td></td>
<td>GHz</td>
</tr>
<tr>
<td>(F_{\text{atten}}) (\text{Common Mode Stop Band Attenuation})</td>
<td>@ 750 MHz</td>
<td>30</td>
<td></td>
<td></td>
<td>dB</td>
</tr>
<tr>
<td>(V_{\text{ESD}}) (\text{In-system ESD Withstand Voltage})</td>
<td>(Notes 1 and 2)</td>
<td></td>
<td>(\pm 15)</td>
<td></td>
<td>kV</td>
</tr>
<tr>
<td>(V_{\text{CL}}) (\text{TLP Clamping Voltage})</td>
<td>Forward (I_{\text{PP}} = 8\ \text{A}) (</td>
<td>\text{Forward} I_{\text{PP}} = 16\ \text{A}) (</td>
<td>\text{Forward} I_{\text{PP}} = -8\ \text{A}) (</td>
<td>\text{Forward} I_{\text{PP}} = -16\ \text{A})</td>
<td>8.94</td>
</tr>
</tbody>
</table>

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

1. Standard IEC61000-4-2 with \(C_{\text{Discharge}} = 150\ \text{pF, R}_{\text{Discharge}} = 330,\ \text{GND grounded.}\)
2. These measurements performed with no external capacitor.
3. TVS devices are normally selected according to the working peak reverse voltage \(V_{\text{RWM}}\), which should be equal to or greater than the DC or continuous peak operating voltage level.
4. \(V_{\text{BR}}\) is measured at pulse test current \(I_T\).
TYPICAL CHARACTERISTICS

Figure 2. Typical Differential Mode Attenuation vs. Frequency

Figure 3. Typical Common Mode Attenuation vs. Frequency

<table>
<thead>
<tr>
<th>Interface</th>
<th>Data Rate (Gb/s)</th>
<th>Fundamental Frequency (MHz)</th>
<th>ESD813x Differential Insertion Loss (dB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MIPI</td>
<td>1.5</td>
<td>750</td>
<td>m1 = 1.25</td>
</tr>
</tbody>
</table>

Figure 4. Differential Mode Insertion Loss
Transmission Line Pulse (TLP) provides current versus voltage (I–V) curves in which each data point is obtained from a 100 ns long rectangular pulse from a charged transmission line. A simplified schematic of a typical TLP system is shown in Figure 5. TLP I–V curves of ESD protection devices accurately demonstrate the product’s ESD capability because the 10 s of amps current levels and under 100 ns time scale match those of an ESD event. This is illustrated in Figure 6 where an 8 kV IEC61000–4–2 current waveform is compared with TLP current pulses at 8 A and 16 A. A TLP curve shows the voltage at which the device turns on as well as how well the device clamps voltage over a range of current levels. Typical TLP I–V curves for the EMI813x are shown in Figure 5.

![Figure 5: Simplified Schematic of a Typical TLP System](image)

![Figure 6: Comparison Between 8 kV IEC6100-4-2 and 8 A and 16 A TLP Waveforms](image)

![Figure 7: Positive and Negative TLP Waveforms](image)
MECHANICAL CASE OUTLINE
PACKAGE DIMENSIONS

XDFN10 2.2X1.35, 0.4P
CASE 711AU
ISSUE B

DATE 17 JUN 2014

NOTES:
2. CONTROLLING DIMENSION: MILLIMETERS.
3. DIMENSIONS b APPLIES TO PLATED TERMINAL AND IS MEASURED BETWEEN 0.15 AND 0.30 MM FROM THE TERMINAL TIP.

NOTE 3
A
A1
0.00 0.05
A3
b
0.15 0.25
D
2.20 BSC
E
1.35 BSC
e
0.40 BSC

NOTES:
2. CONTROLLING DIMENSION: MILLIMETERS.
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GENERIC MARKING DIAGRAM*

XX M

XX = Specific Device Code
M = Date Code
• = Pb-Free Package

*This information is generic. Please refer to device data sheet for actual part marking.
Pb-Free indicator, “G” or microdot “•”, may or may not be present.

RECOMMENDED MOUNTING FOOTPRINT

DIMENSIONS: MILLIMETERS

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DETAIL A
ALTERNATE TERMINAL CONSTRUCTIONS

EXPOSED Cu
MOLD CMPD

DETAIL B
ALTERNATE CONSTRUCTION

NOTES:
2. CONTROLLING DIMENSION: MILLIMETERS.
3. DIMENSIONS A, A3, A1 APPLY TO PLATED TERMINAL AND IS MEASURED BETWEEN 0.15 AND 0.30 MM FROM TERMINAL TIP.

DIMENSIONS: MILLIMETERS

SCALE 4:1

DATE 04 JUN 2014

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3. DIMENSION b APPLIES TO PLATED TERMINAL AND IS MEASURED BETWEEN 0.15 AND 0.30 mm FROM THE TERMINAL TIP.

DETAIL A
ALTERNATE TERMINAL CONSTRUCTIONS

DETAIL B
ALTERNATE CONSTRUCTION

EXPOSED Cu
MOLD CMPD

DIMENSIONS: MILLIMETERS

MILLIMETERS

<table>
<thead>
<tr>
<th>DIM</th>
<th>MIN</th>
<th>MAX</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0.40</td>
<td>0.50</td>
</tr>
<tr>
<td>A1</td>
<td>0.00</td>
<td>0.05</td>
</tr>
<tr>
<td>A3</td>
<td>0.15</td>
<td>0.25</td>
</tr>
<tr>
<td>b</td>
<td>0.15</td>
<td>0.25</td>
</tr>
<tr>
<td>D</td>
<td>3.52 BSC</td>
<td></td>
</tr>
<tr>
<td>E</td>
<td>1.35 BSC</td>
<td></td>
</tr>
<tr>
<td>e</td>
<td>0.46 BSC</td>
<td></td>
</tr>
<tr>
<td>L</td>
<td>0.40</td>
<td>0.60</td>
</tr>
<tr>
<td>L1</td>
<td>0.15</td>
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</tbody>
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DETAILS:
- **TOP VIEW**
- **SIDE VIEW**
- **BOTTOM VIEW**

**RECOMMENDED SOLDERING FOOTPRINT**

**GENERIC MARKING DIAGRAM**

**NOTES:**
- This information is generic. Please refer to device data sheet for actual part marking.
- Pb−Free indicator, "G" or microdot "•", may or may not be present.

**DESCRIPTION:** XDFN16 3.5X1.35, 0.4P

**DATE:** 17 JUN 2014

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